
Coherent Electrostatic Solitary Waves in the Inner Heliosphere

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Abstract

The solar wind and planetary magnetospheres provide excellent natural laboratories to study the basic physics of collisionless plasmas. In these systems, microscopic plasma physics often influences, or even controls, global plasma dynamics by controlling transport of energy and momentum. Electromagnetic fluctuations and the resulting wave-particle interactions are particularly omnipresent. Typical spectra of electromagnetic fluctuations in the solar wind are power laws in frequency, with multiple characteristic breaks signaling changes in the origin of fluctuating modes, as well as onset of dissipation. At frequencies above the electron cyclotron frequency, fluctuations become purely electrostatic, and a persistent level of broadband electrostatic noise is often observed.

High-resolution measurements reveal that these small-scale modes often contain highly coherent wave-packets and solitary structures, the latter likely being electron or ion phase space holes of a few tens of Debye length in size. These bipolar electric field structures can be weak double layers (WDLs), a localized and stable charge separation sustaining a net potential drop across. WDLs are often associated with particle acceleration and energy dissipation.

We present here a preliminary work in which we analyze data from various missions to search for and detect electrostatic solitary waves and WDLs in the inner heliosphere from the solar corona to 1 AU using electric field measurements from Parker Solar Probe, Solar Orbiter, MMS and Wind. Do WDLs observed in the near-Sun solar wind have finite potential drops oriented radially so as to slow escaping electrons and accelerate escaping ions?

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